

CLAIMS

1. An apparatus for monitoring a detection region (6) of a working element, having at least one camera (5) for continuously detecting the detection region (6), further having an evaluation unit, into which image information that has been generated by the camera (5) is read, the information being used in a comparison to reference images stored in the evaluation unit, and/or in a color-feature analysis, to detect endangered objects within at least one protection zone (7) inside the detection region (6), wherein, when at least one endangered object is detected within the protection zone (7), the working element is disabled, and the evaluation unit enables the working element if no endangered object is located inside the protection zone (7).

2. The apparatus according to claim 1, characterized in that a switching output that is guided from the evaluation unit to the working element assumes a defined switching state, depending on whether an endangered object is located in the protection zone (7), and the working

element is enabled or disabled, depending on this switching state.

3. The apparatus according to claim 1 or 2, characterized in that, in addition to the protection zone (7), at least one warning zone (8) is defined inside the monitoring region detected by the camera (5), with the evaluation unit activating a warning indicator if an endangered object is located in the warning zone (8).

4. The apparatus according to claim 3, characterized in that the warning indicator is connected to the evaluation unit by way of a warning output, with the warning indicator being activated or deactivated, depending on the switching state of the warning output.

5. The apparatus according to claim 3 or 4, characterized in that the warning indicator emits an optical and/or an acoustical warning signal.

6. The apparatus according to one of claims 3 through 5, characterized in that the warning zone (8) borders the protection zone (7).

7. The apparatus according to claim 6, characterized in that the direction of movement of an endangered object located inside the warning zone (8) can be detected.

8. The apparatus according to claim 7, characterized in that the warning indicator is only activated if an endangered object located inside the warning zone (8) is moving toward the protection zone (7).

9. The apparatus according to one of claims 3 through 8, characterized in that a plurality of protection zones (7) and warning zones (8) is provided, with a switching output being associated with each protection zone (7) and a warning output being associated with each warning zone (8).

10. The apparatus according to claim 9, characterized in that the evaluation unit disables the working element if an endangered object is located in at least one protection zone (7).

11. The apparatus according to one of claims 3 through 10, characterized in that the dimensions of the protection zones (7) and warning zones (8) can be selected through the input of parameter values into the evaluation unit.

12. The apparatus according to one of claims 3 through 11, characterized in that the dimensions of the protection zones (7) and warning zones (8) can be predetermined through a learning process.

13. The apparatus according to one of claims 3 through 12, characterized in that display elements visually indicate the switching states of the switching outputs and warning outputs.

14. The apparatus according to one of claims 1 through 14 [sic], characterized in that regions inside the detection region (6) can be extracted for predetermined time intervals, so if endangered objects enter these regions, the working element is not disabled via a switching output, and the warning indicator is not activated via a warning output.

15. The apparatus according to one of claims 1 through 13, characterized in that the border of a protection zone (7), which extends, at least by sections, in a straight line, can be visually represented by a visible light beam.

16. The apparatus according to one of claims 1 through 15, characterized in that the evaluation unit, with the camera (5) or cameras (5), is connected via a safety bus system to the control of the working element.

17. The apparatus according to one of claims 1 through 16, characterized in that the camera (5) is seated in a form-fit on a mechanical holding device, which can be adjusted in the three spatial directions, independently of the camera (5).

18. The apparatus according to one of claims 1 through 17, characterized in that an active, separate illumination system is associated with the camera (5), or each camera (5).

19. The apparatus according to one of claims 1 through 18, characterized in that the working element is formed by a folding press (1), which has at least one upper tool (3) that cooperates with at least one lower tool (4).

20. The apparatus according to claim 19, characterized in that the protection zone (7) encompasses the fold line between the upper tool (3) and the lower tool (4).

21. The apparatus according to claim 19 or 21, characterized in that the folding press (1) includes numerous pairs of cooperating upper tools (3) and lower tools (4), with a camera (5) monitoring a predetermined number of such pairs of upper tools (3) and lower tools (4).

22. The apparatus according to one of claims 1 through 18, characterized in that the working element is formed by a printing press (9) having a feeder and an output.

23. The apparatus according to claim 22,
characterized in that at least one camera (5) detects the
feeder (10) and/or the output of the printing press (9) as
a detection region (6).

24. The apparatus according to claim 22,
characterized in that the paper-intake region at the feeder
(10) of the printing press (9) can be detected as a
detection region (6) by a camera (5).

25. The apparatus according to one of claims 1
through 24, characterized in that a working robot
constitutes the working element.

26. The apparatus according to one of claims 1
through 25, characterized in that persons constitute the
endangered objects.

27. The apparatus according to one of claims 1
through 26, characterized in that human hands and/or
fingers constitute the endangered objects.

28. A method for monitoring a detection region (6) of a working element by means of an apparatus according to one of claims 1 through 27, the method comprising the following steps:

at least one camera (5) continuously detects a detection region (6);

the image information generated in the camera (5) during the detection is read, in the form of color values, into an evaluation unit;

the read-in color values are used to distinguish endangered objects from non-endangered objects; and

if at least one endangered object is detected within at least one protection zone (7) in the detection region (6), the evaluation disables the working element, whereas the evaluation unit enables the working element if no endangered object is located in the protection zone (7).

29. The method according to claim 28, characterized in that an image generated by the camera (5) is read into the evaluation unit in the form of a pixel matrix with different color values; and in the evaluation unit, for distinguishing endangered objects from no-endangered objects, the color values are assessed with a threshold-

value unit, with binary images being created from the read-in images.

30. The method according to claim 29, characterized in that the threshold-value unit is a component of a neuronal network.

31. The method according to claim 29 or 30, characterized in that three color values of the base colors of red, green and blue are associated with each pixel of an image that has been read into the evaluation unit, and a linear combination is created from the individual color values that have been weighted with predetermined weighting factors in the evaluation unit; and the linear combination of color values is assessed with the threshold-value unit.

32. The method according to claim 31, characterized in that, for determining the threshold value or values of the threshold-value unit, and/or the weighting factors, the colors of the endangered objects are learned in a learning process.

33. The method according to one of claims 29 through 31, characterized in that, if endangered objects comprising persons, their hands and/or their fingers are present, the objects have a protective covering of a predetermined color, with the threshold value or values of the threshold-value unit being adapted to the color of the protective covering.

34. The method according to one of claims 29 through 33, characterized in that, in a binary image generated by the threshold-value unit, the endangered objects form a connected region of foreground pixels; and individual foreground pixels in the background surrounding this region are eliminated from regions with background pixels by means of morphological operators.

35. A method for monitoring a detection region (6) of a working element by means of an apparatus according to one of claims 1 through 27, the method comprising the following steps:

at least one camera (5) continuously detects a detection region (6);

the image information generated in the camera (5) during the detection is read into an evaluation unit; endangered objects are detected inside at least one protection zone (7) in the detection region (6) through a comparison of the image information to reference images stored in the evaluation unit; and

if at least one endangered object is detected within the protection zone (7), the evaluation disables the working element, whereas the evaluation unit enables the working element if no endangered object is located in the protection zone (7).

36. The method according to claim 35, characterized in that, for assessing the images and reference images, the images are converted into binary edge images through the assessment of the amounts of the gradients of their brightness distributions.

37. The method according to claim 35 or 36, characterized in that the protection zone (7) is bordered by a reference object having a defined contrast pattern that forms at least a portion of the reference image or a reference image.

38. The method according to one of claims 35 through 37, characterized in that, during a learning process, the machining steps for a workpiece (2) that constitutes a non-endangered object are detected with the working element by the camera (5); and, for distinguishing endangered objects from non-endangered objects, the recorded images are compared to the reference images recorded during the learning process.

39. The method according to claim 38, characterized in that the protection zones (7) and/or the warning zones (8) can be changed over the course of the machining steps.

40. The method according to one of claims 28 through 39, characterized in that a self-test is performed at predetermined intervals for checking the device function.

41. The method according to claim 40, characterized in that a static self-test is performed, in which the presence of predetermined fixed points in the images generated by a camera (5) or the camera (5) is checked.

42. The method according to claim 40 or 41,
characterized in that a dynamic self-test, in which the
presence of a test object brought into the protection zone
(7) is checked, is performed at predetermined times.